

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 11/7/2007 has been entered.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claims 35-36, 38-39, 41-42 and 44-50 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In these claims the limitations “providing a signal having a frequency” in claim 35 is unclear. It is not clear which signal and which frequency is being referred to here.

In the limitation “determining at least one calibrating endpoint by performing an empirical analysis on the at least one sample substrate” the underlined part is unclear. However, according to the specification it appears to refers to determining a harmonic of the applied RF frequency at which an electrical signal like voltage, current or phase could be used for detection of an etching endpoint.

In the limitation “etching, in the plasma processing chamber, at least one test substrate using one or more signals having the frequency, the at least one test substrate being etched over at least one time duration, the at least one time duration including the at least one calibrating endpoint;” the underlined part is unclear.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 35-36, 39, 41, 44-48 and 50 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Turner et al (US 5576629).

Turner et al disclose monitoring electrical parameters of a plasma during an etch process, (Abstract). Further the electrical parameters could be current, voltage, phase and their harmonics (Col 1 lines 8-14, Col 5 lines 1-14 and lines 50-65) and the harmonic analysis could be used for process control and determination of endpoint (Col 7 and Col 8). Specifically, Turner et al state that analysis of different harmonics allows for understanding the relationship (model) of electrical parameters and process variables (Col 8 lines 22-33). Further this allows determination of end point or other process parameter done by comparing with predetermined historical data (Col 8 lines 20-47). The structural hardware provides for sensors for current and probe for voltage (Col 8 line 64-65). It is inherent and obvious that for generating a model from historical

data a sample should undergo etching for a time period to fully enclose the end point in order to learn the behavior of the electrical parameter at the end point. Turner et al further disclose harmonic analysis of the applied fundamental frequency to develop a best model for endpoint determination while the applied frequency could be selected from 0.1-13.56 MHz which is generally recognized as the operating frequency range (Col 1 lines 20-25).

Regarding the amendment of time window, it is obvious that during the period when the model is being established electrical parameters should be monitored at least during the time endpoint occurs so as not to miss the endpoint. The whole idea of the generation of model is to take a snap shot of events occurring from a point just before endpoint to a point just after the endpoint.

6. Claims 35-36, 39, 41-42 and 44-50 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Butler et al (US 5458732).

Butler et al disclose monitoring electrical parameters of a plasma during an etch process (Col 5 lines 13-18) at both upper electrode as well as at lower electrode. Further the electrical parameters could be current, voltage; phase and their harmonics (Abstract, Col 3 lines 51- 63) and the harmonic analysis could be used for process control and determination of endpoint (Col 6 lines 64 to Col 7 line 1). Specifically, Butler et al state that different harmonics may have different behavior (Col 3 lines 56-63), which allows for selecting a suitable harmonic. Further this allows determination of end point or other process parameter done by comparing with predetermined historical data. It is inherent and obvious that for generating a model from historical data a sample should undergo etching for a time period to fully enclose the end point in

order to learn the behavior of the electrical parameter at the end point. Further Butler et al disclose harmonic analysis of the applied fundamental frequency to develop a best model for endpoint determination while the applied frequency could be selected from up to 40 MHz.

Regarding the amendment of time window, it is obvious that during the period when the model is being established electrical parameters should be monitored at least during the time endpoint occurs so as not to miss the endpoint. The whole idea of the generation of model is to take a snap shot of events occurring from a point just before endpoint to a point just after the endpoint.

7. Claims 35-36, 39, 41, 44-48 and 50 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Miyashita et al (JP 08227875).

Miyashita et al disclose monitoring electrical parameters of a plasma, during an etch process and teach that end point is determined by monitoring a change in a specific harmonic (Abstract and claims 14-16 from the machine translation in English). Further Miyashita et al disclose determination of correlation between a specific harmonic and a material present in the plasma whose concentration changes at the end point (Paragraphs 11-13, 27-29).

Regarding the amendment of time window, it is obvious that during the period when the model is being established electrical parameters should be monitored at least during the time endpoint occurs so as not to miss the endpoint. The whole idea of the generation of model is to take a snap shot of events occurring from a point just before endpoint to a point just after the endpoint.

Claim Rejections - 35 USC § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

9. **Claim 38 is rejected under 35 U.S.C. 103(a) as being unpatentable over Turner et al (5576629) in view of Kagoshima et al (US Pub 2003/0003607).**

Turner et al disclose determination of end point or other process parameter done by comparing with predetermined historical data but do not disclose how actual measurement of etch depth is obtained.

Using SEM is common to measure etching depths as taught by Kagoshima et al (Fig 2).

Therefore using an SEM for actual measurement would have been obvious for one of ordinary skill in the art at the time of invention.

10. **Claims 42 and 49 are rejected under 35 U.S.C. 103(a) as being unpatentable over Turner et al (5576629) in view of Butler et al (US 5458732).**

Turner et al do not disclose electrical parameter measurement at upper electrode as well as lower electrode.

Butler et al disclose monitoring electrical parameters of a plasma during an etch process (Col 5 lines 13-18) at both upper electrode as well as at lower electrode.

Therefore measuring electrical parameter at both electrodes would have been obvious in order to provide more choice in finding a parameter for endpoint detection.

Response to Arguments

Applicant's arguments filed 11/7/2007 have been fully considered but they are not persuasive.

Applicant argues that none of Turner, Butler, and Miyashita teaches comparing harmonics of a frequency for parameters and selecting a harmonic of the frequency, for a parameter as an endpoint indicator based on sensitivity or repeatability.

It is noted that Turner discloses employing radio frequency harmonic analysis for the purpose of determining endpoint detection, statistical process control, and the existence of a go-no-go situation that may indicate an out-of-control process. The advantage of using harmonics is that there is no dead band process control or tapering off in the measurements that result. This provides the most rapid or instantaneous process control for any plasma processing environment. The present embodiment analyzes harmonic amplitudes and matches them to known good historical values using the simple mathematical algorithm. The parameters that the present embodiment employs permits modeling of plasma process parameters that can relate to stress, thickness, deposition rate and other parameters.

It is clear from the underlined part that good historical values can come only by comparing several values to find best fit.

Similarly Butler discloses that different harmonics have different behavior and response and teaches analyzing frequency spectrum of fundamental, harmonic and sub-harmonic

frequencies for several uses (Col 6 lines 44-50). Butler et al go on to specifically point out its use for detecting endpoint. For example, the method and system may be used to check for uniformity and endpoint measurements of a processing step. Of course, when making uniformity measurements the uniformity of the starting material must be considered.

Further Miyashita is also very specific about this determination.

Regarding starting detection of suitable harmonic, it is obvious that etching process must precede such process of detection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ram N. Kackar whose telephone number is 571 272 1436. The examiner can normally be reached on M-F 8:00 A.M to 5:P.M.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Parviz Hassanzadeh can be reached on 571 272 1435. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Ram N Kackar/
Primary Examiner, Art Unit 1792